

IX. *The Larva of Pelophila.* By the Rev. WILLIAM
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THE ground-beetle *Pelophila borealis* (Payk.) is among the most interesting of our native insects. Spread over the northern parts of Siberia, Russia and Scandinavia, it seems to be entirely absent from Central Europe as well as from the mainland of Great Britain. It occurs however in the Orkneys, while in Ireland it is widely distributed in Ulster, Connaught and Munster, down to the south-western corner of the island. This beetle is, perhaps, the most striking instance of a typically Arctic species ranging in Ireland far to the south, where it finds itself in company with the characteristically southern animals and plants of the Lusitanian fauna and flora. *Pelophila borealis* and one other species of the genus inhabit Europe, while several other species have been described from the northern parts of Asia and America. The genus, therefore, has a complete circumpolar range.

Systematic writers on the Coleoptera class *Pelophila* with *Leistus*, *Nebria*, and *Eurynebria* in the tribe Nebriina,* which is distinguished from the nearly allied Elaphrina (comprising *Blethisa* and *Elaphrus*) by the coxal cavities of the front legs being open behind. Fowler remarks however† that *Pelophila* appears to form somewhat of a connecting link between the two tribes; although its mouth-parts resemble those of *Nebria*, the general form of the beetle is like that of *Blethisa*. It will be seen that, in the larval stage, *Pelophila* in several most important points of structure differs from *Nebria* and *Leistus* and agrees with *Elaphrus*. On larval characters it will now be impossible to discriminate sharply between the two sections.

* Fowler and Sharp, "Catalogue of British Coleoptera," London, 1893. Ganglbauer, "Die Käfer von Mitteleuropa," i, Wien, 1892.

† "The Coleoptera of the British Islands," i, London, 1887.

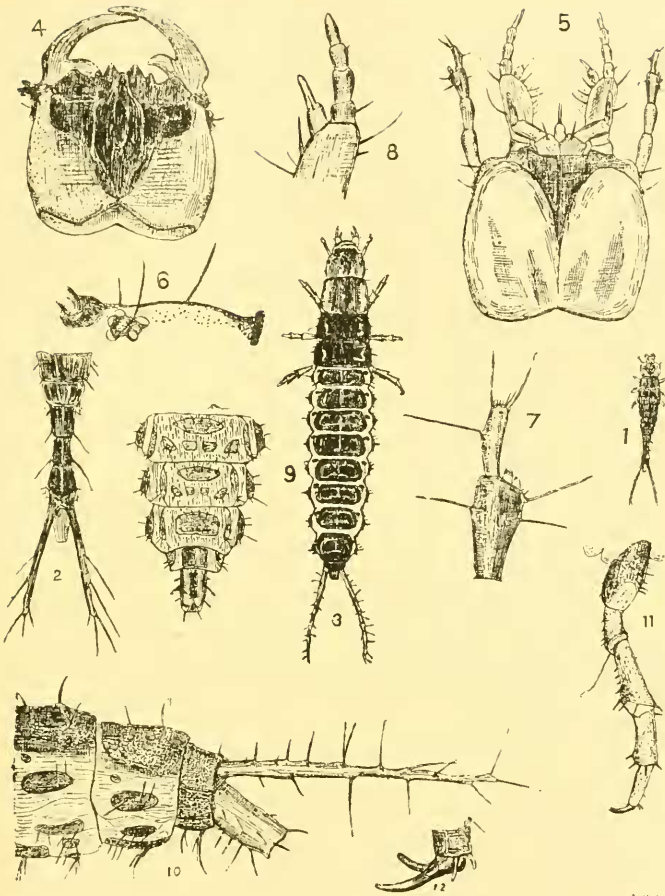
LIFE-HISTORY AND HABITS.

So far as we know the early stages of *Pelophila* have not hitherto been described. It seems worth while, therefore, to place on record a few facts concerning the life-history of *P. borealis* which one of us has been able to observe during several years' collecting in the neighbourhood of Armagh, together with a detailed account of the external structure of the full-grown larva.

The female beetle lays her eggs in the ground. They are hatched in the course of three or four days, and the grubs, when they first emerge, are white and soft-skinned. At the age of four days, the larva has attained a length of 4 mm. and is covered with dark chitinous armour. The insect at this stage (Fig. 1) scarcely differs in structure from the full-grown larva, except for the very marked constriction at the seventh abdominal segment, and the simple form of the cerci (Fig. 2). At this early stage, these are fixed processes of the ninth abdominal segment, not mobile appendages as they become in the full-grown larva (Fig. 10). There are, moreover, but few nodular tubercles and setæ, as compared with the complex arrangement developed at a later stage.

By feeding the grubs on raw beef which they devoured greedily, it was possible to rear them until they had attained their full growth. The time taken in completing the larval development was about a fortnight. Full-grown larvæ were subsequently discovered in well-known haunts of the beetle, their identity being placed beyond doubt by their correspondence with the grubs which had been reared from the eggs. Unfortunately none of the larvæ pupated, as all those reared to their full size met with accidents. They seemed to devour their cast skins, as none of these were found, and one was observed devouring what appeared to be its cast skin.

In their native haunts the habits of the larva are much the same as those of the perfect insect. They live on the borders of lakes and banks of rivers preferring a firm clay bank with plenty of loose stones lying on it. They are always found at a short distance from the water where the ground is moist, a condition which seems indispensable to their well-being. The larvæ are very active and run about quickly when disturbed. They hide under stones and they either wait for their prey there, or else pursue



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DESCRIPTION OF FIGURES.

1. Young larva (four days old) of *Pelophila borealis* (Payk.)
 2. Hinder end of young larva, showing cerci. 3. Full-grown larva of *Pelophila borealis*. 4. Head from above, with mandibles.
 5. Head from beneath, with antennæ, maxillæ, and labium. 6. Ocelli, from side. 7. Terminal segments of antenna. 8. End of maxilla.
 9. Terminal abdominal segments, from beneath. 10. Terminal abdominal segments, anal tube, and cercus from side. 11. Leg of the first pair. 12. End of tarsus and claws.

it at night. During the earlier stages of its existence the larva must hide very carefully as it has not been found in its haunts until full-grown or nearly so. When full-grown the larva is easily observed, just like the imago by turning over stones in the place it frequents. The larva, when young, is more restless than when full-grown; it runs about trying things with its mandibles evidently in search of food. When full-grown it becomes less restless and though if disturbed it makes off with great rapidity rushing into any hiding place that offers, yet otherwise it sits quietly in the one spot.

The perfect insect is most plentiful in the months of May and June, but it has occurred as early as April 4th and as late as October 4th. The larvæ are to be found in August and September. From these dates it would seem probable that the beetle hibernates either in the pupal or in the imaginal state. That the latter occurs, in some cases, was shown by experiment. Several specimens were placed in a flower pot and covered with a glass shade; they vanished during the winter but reappeared in the spring, quite well, though no food had been supplied to them for five months. They had evidently spent the intervening time in a state of torpor. Their place of concealment when under natural conditions has not been detected. At Lough Neagh, and also at Lowry's Lough near Armagh, the locality they haunt in the summer is in winter covered with water, so that they must retire to a position above the reach of the floods and here burrow into the ground, for they were not found in moss taken from the bank at Lowry's Lough where they were most likely to have taken refuge. We have no facts bearing on the duration of the beetle's life, except that specimens captured during the first week in August bred, and were still alive and vigorous, at the end of the month when they were removed to avoid the danger of their attacking the young larvæ.

STRUCTURE OF FULL-GROWN LARVA.

The full-grown grub of *Pelophila borealis* measures 14—15 mm. in length. It is of elongate form, attaining its greatest breadth (2.5 mm.) at the third segment of the abdomen, whence it tapers gently towards the head and more decidedly towards the tail-end. (Fig. 3.)

Head. The head is subquadrate, flat above with a deep median groove, and a deep lateral depression behind each antenna; hardly produced in front, the margin of the clypeus bearing four teeth of which the centrals are more prominent than the laterals; slightly convex at sides and beneath; rather strongly emarginate behind, but not constricted into a neck. Above and in front, the surface of the head is black and rugose, the epicranial and lower lobes are smooth and yellow, each lobe beneath being marked with two longitudinal dark streaks (Figs. 4, 5). There are six ocelli on each side, situated just behind the antenna, arranged in two transverse rows of three each; the forward row is the longer, and its two terminal ocelli are the largest of the six, the dorsal ocellus of the hinder row being only slightly smaller (Fig. 6).

Antennæ. These are rather shorter than the head; the first segment is the longest, the second and third each three-quarters as long as the first, the fourth three-quarters as long as the third (Fig. 5). The third segment is enlarged distally and carries three papillæ, of which the longest shows rudimentary segmentation; at the end of the fourth segment are two papillæ (Fig. 7).

Mandibles. As long as the antennæ, rather slender, evenly curved, bearing a stout tooth near the base (Fig. 4).

Maxillæ. The stipes is elongate nearly half as long as the head; the lacinia is represented by a minute setigerous papilla; the galea is two-segmented, with the distal segment slightly longer than the proximal; the palpigerous stipes is short and cylindrical; the palp is three-segmented with the first segment slightly longer than the third, and the third, which is conical, slightly longer than the second (Fig. 8).

Labium. The palpigerous stipites are short, cylindrical and divergent; the palp is two-segmented, the proximal segment stout and cylindrical and rather longer than the distal which is slender and conical; the ligula is elongate, rounded at the tip, and bearing two long setæ inserted close together, and directed straight forwards parallel to one another (Fig. 5).

Thorax. The pronotum is trapezoidal, its length equal to its breadth in front, which is as broad as the head; evidently widened behind; there are two lateral depres-

sions; the colour is deep black in the centre, shading off to dark brown at the sides.

The mesonotum and metanotum are each three-quarters as long as the pronotum, deep black, each with two lateral sinuate depressions.

A central longitudinal suture is apparent on the dorsal aspect of all the thoracic and abdominal segments.

The prothorax is chitinous beneath from the front margin to the insertion of the legs. In the meso- and metathorax, the sternite is reduced to a small subtriangular median plate.

Legs. The legs are of moderate length, the two hinder pairs as long as the breadth of the metathorax, the front pair rather shorter. The coxa is twice as long as broad, its outer surface bearing a row of strong setæ. The trochanter is half as long as the coxa, thickened distally, bearing on its inner surface a double row of spines and a long tactile seta. The femur is slightly longer than the coxa, bearing spines along its inner margin (in double row), and around its thickened distal extremity. The tibia is two-thirds as long as the femur, slightly thickened distally, bearing a single external basal spine and a prominent subapical series. The tarsus is slightly shorter than the tibia, cylindrical, bearing a fine spine near the base, and two stout ones at apex; the two claws are equal in length, slightly curved and ending in a blunt point (Figs. 11, 12).

Abdomen. The terga of segments 1—8 are similar in form, transverse with anterior and posterior ridges and lateral sinuate depressions; the tergum of the ninth segment is much narrower and shorter than the preceding. The pleuræ of segments 1—8 are oblong-oval, that of segment 9 oblong. There are seven ventral plates on each of the segments 1—7: a transverse hexagonal anterior plate, four small plates arranged transversely posterior thereto, the two centrals being subquadrate and the two laterals subtriangular, and a pair of lateral oval plates arranged longitudinally. The eighth segment has a single quadrate central plate, and the pair of lateral oval plates as the preceding segments. The ninth segment has only a single ventral plate (Fig. 9). The anal cylinder is about twice as long as its diameter or as the length of the ninth segment. The cerci are long and mobile, provided with numerous nodulose tubercles bear-

ing long setæ, the arrangement of which does not exactly correspond in the two cerci of the same individual (Fig. 10).

COMPARATIVE MORPHOLOGY OF THE LARVA.

As mentioned above, the genus *Pelophila* is classed, by its imaginal characters, with *Leistus* and *Nebria*. In the larval stage it resembles those genera in the possession of long, mobile cerci, as well as in the general structure of the antennæ and mouth-parts. But it differs widely from them in its broad quadrate head and short legs with equal tarsal claws. The larva of *Pelophila* indeed shows relationships with various carabidous larvæ of widely separated genera. The form of the head, without the constricted neck so characteristic of the *Nebriina*, recalls that of *Elaphrus*, and still more perhaps that observed in certain Harpaline genera, such as *Brosicus*, *Chlænius* and *Pterostichus*.* The larva of *Pelophila* agrees with these latter in the insertion of the antennæ over the base of the mandibles. The head-appendages agree generally with those of the *Nebriine* larvæ, as well as with those of *Elaphrus*; in the proportional lengths of the segments of the maxillary galea *Pelophila* is intermediate between these two groups. The long paired setæ of the labial ligula again recall the larval characters of *Brosicus* and *Chlænius*. A character in which our larva is most clearly separated from the *Nebriina* is the comparative shortness of the legs, which by the arrangement of the spines and the equality of the two tarsal claws resemble those of *Elaphrus* and the Harpalinæ. It is remarkable that *Amara* seems the only other carabidous genus in which the larval tarsi are shorter than the tibiæ. The abdominal cerci are the most unequivocal *nebriine* structures to be found in our larva. It is of some interest to note that while the cerci of the full-grown *Pelophila* grub closely resemble those of *Nebria*, in the young larva they are simpler, as in the full-grown grub of *Leistus*. As mentioned above, these cerci are mobile in the full-grown larva, but not in the young. In the majority of carabidous genera these appendages appear to remain fixed throughout larval life.

* Schiodte, "De Metamorphosi Eleutheratorum," Pars. III. (Naturh. Tidsskr. iv. 1867.)

RELATIONSHIP OF PELOPHILA TO OTHER CARABIDÆ.

The combination in the grub of *Pelophila* of structures characteristic of the *Notiophilina*, *Nebriina* and *Elaphrina* suggests that we have to do with an archaic type near to the common ancestors of these tribes, a view supported by the restricted northern range of *Pelophila* and the small number of its species. Also the similarity in several points between the grub of *Pelophila* and those of harpaline beetles gives evidence that it must be regarded as a generalised member of the Carabidæ since it shows affinities with such dissimilar types. There can be little doubt that the possession of long abdominal cerci is an archaic character, when we consider that such appendages are found in primitive insects such as the *Thysanura*, *Ephemeroidea* and *Perlids*. The fact that in the young larva of *Pelophila* the cerci are comparatively short, and fixed, might indeed be thought inconsistent with such a view. But it is possible to regard the persistence of this condition of the cerci in the great majority of carabidous larvæ as an instance of arrested development. The long legs of the larvæ of *Loricera*, *Notiophilus*, *Nebria* and *Leistus*, the head constricted behind into a narrow neck, and (in *Leistus* and *Notiophilus*) drawn out in front into long spinose processes, appear on the other hand to be specialised characters, adapted to ready and rapid motion. From such a larva as that of *Pelophila*, then, can be derived, on the one hand, those of the *Nebriina* and *Notiophilina*, in which the head and legs have become highly modified while the primitive cerci have been retained; on the other hand, those of *Elaphrus* and the majority of the *Harpalinæ*, in which the primitive quadrate head and short legs have been retained while the long cerci have become greatly reduced.